Human Research Program
Space Human Factors Engineering

SHFE Mapping of IRP Rev B Risks to IRP Rev C Risks

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Organization of Presentation

- Overview of Rev B to Rev C Risk Restructuring, Gap Mapping
  - Includes Full Risk Titles
  - Includes recommended Short Risk Titles
- Detailed Gap Mapping of Gaps from Rev B (Old) to Rev C (New)
  - Clear identification of FROM/TO for each Gap
- Rationale for the Change
  - Cleaner Risk Statements, Less overlap among Risks
  - Alignment with DoD's Human Factors Analysis Classification System (HFACS)
- Schedule for updating Evidence Reports
- Status/plans for RMAT vetting at HSRB

SHFE Rev B Risks

Risk of Error Due to Inadequate Information (10 Gaps)

Risk of Reduced Safety and Efficiency Due to an Inadequately Designed Vehicle, Environment, Tools, or Equipment (8 Gaps)

Risk of Error Due to Poor Task Design (5 Gaps)

SHFE Rev C Risks

SHFE-HAB
Risk of an Incompatible Vehicle/Habitat Design (6 Gaps)

SHFE-HARI
Risk of Inadequate Design of Human and Automation/Robotic Integration (4 Gaps)

SHFE-HCI
Risk of Inadequate Human-Computer Interaction (7 Gaps)

SHFE-TASK
Risk of Poor Critical Task Design (3 Gaps)

SHFE-TRAIN
Risk of Performance Errors Due to Training Deficiencies (3 Gaps)

SHFE Rev B Risks

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SHFE Rev C Risks

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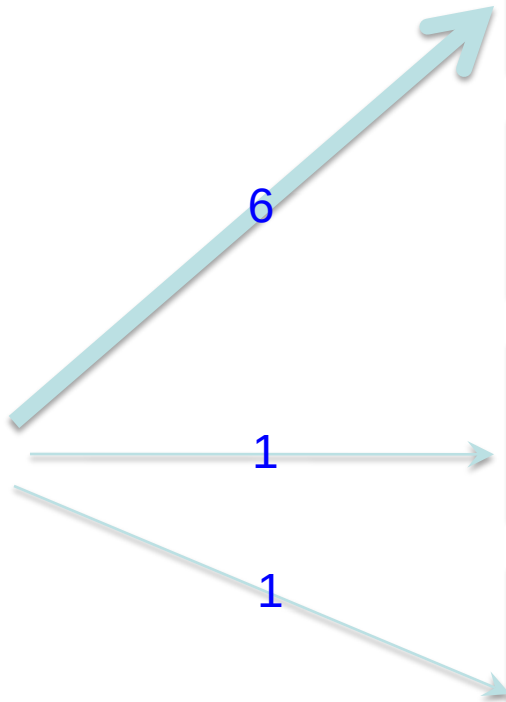

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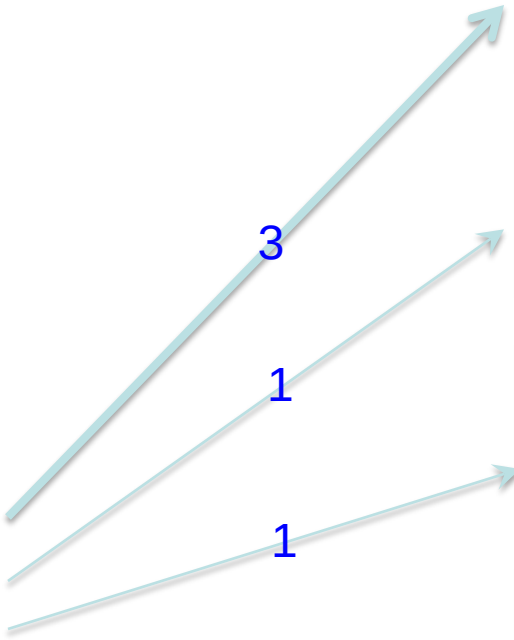

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Old to New Mapping

Risk - Rev B	Gap #	Map to New Risk	Proposed New Gap #	Rev B Gap Number and Statement	New Gap Number and Statement
Inadequate Information	HCI-5	HARI	SHFE-HARI-04	HCI-5: What are the effects of the delays typical of different mission regimes on teleoperations and how do we mitigate these effects?	SHFE-HARI-04: What are the effects of the delays typical of different mission regimes on teleoperations and how do we mitigate these effects?
Inadequate Information	HCI-1	HCI	SHFE-HCI-01	HCI-1: What are the effects of vibration and acceleration on crew task performance and how can those effects be mitigated?	SHFE-HCI-01: What are the effects of vibration and acceleration on crew task performance and how can those effects be mitigated?
Inadequate Information	HCI-3	HCI	SHFE-HCI-03	HCI-3: Given the design constraints for cockpits and workstations, what HCI guidelines (e.g., display configuration, screen-navigation) will enable the crew to perform tasks in a timely manner with minimal ergonomic problems, even when fatigued or deconditioned?	SHFE-HCI-03: Given the design constraints for cockpits and workstations, what HCI guidelines (e.g., display configuration, screen-navigation) will enable the crew to perform tasks in a timely manner with minimal ergonomic problems, even when fatigued or deconditioned?
Inadequate Information	HCI-4	HCI	SHFE-HCI-04	HCI-4: What are recommended applications of multi-modal or other displays and controls based on new technologies, within nominal and off-nominal conditions of the spacecraft environment? (display modalities?) (What's the best display for situation?)	**SHFE HCI-04**: What are recommended applications of multi-modal or other displays and controls based on new technologies, within nominal and off-nominal conditions of the spacecraft environment; what is the best display modality for a given situation?
Inadequate Information	SHFE 3.1.2.2.a	HCI	SHFE-HCI-06	SHFE 3.1.2.2.a: How do we ensure that the displays and control designs and technology developed for ~~the~~ operational environments ~~of the Cx Program~~ will improve performance and reduce errors?	SHFE-HCI-06: How do we ensure that the displays and control designs and technology developed for operational environments will improve performance and reduce errors?
Inadequate Information	SHFE 3.1.2.2.2.1	HCI	SHFE-HCI-07	SHFE 3.1.2.2.2.1 (SM11): Can crewmember spatiomotor abilities be more accurately predicted and countermeasures and training techniques developed to mitigate spatial disorientation during spaceflight?	SHFE-HCI-07 (SM11): Can crewmember spatiomotor abilities be more accurately predicted and countermeasures and training techniques developed to mitigate spatial disorientation during spaceflight?
Inadequate Information	3.1.2.a	TASK	SHFE-TASK-03	SHFE 3.1.2.a: How can a capability for semi-autonomous planning and dynamically replanning of crew schedules be developed?	SHFE-TASK-03: How can a capability for semi-autonomous planning and dynamically replanning of crew schedules be developed?
Inadequate Information	SHFE 3.1.1.a	TRAIN	SHFE-TRAIN-01	SHFE 3.1.1.a: How can we develop objective training measures to determine operator proficiency during and after ground training?	SHFE-TRAIN-01: How can we develop objective training measures to determine operator proficiency during and after ground training?
Inadequate Information	SHFE 3.1.1.b	TRAIN	SHFE-TRAIN-02	SHFE 3.1.1.b: How do we develop training methods and tools for space medical application if time is minimal?	SHFE-TRAIN-02: How do we develop training methods and tools for space medical application if time is minimal?
Inadequate Information	SHFE 3.1.1.c	TRAIN	SHFE-TRAIN-03	SHFE 3.1.1.c: How can onboard training systems be designed to address Just in Time (JIT) and recurrent training needs for nominal and off nominal scenarios?	SHFE-TRAIN-03: How can onboard training systems be designed to address Just in Time (JIT) and recurrent training needs for nominal and off nominal scenarios?
Safety	PHYS-1	HAB	SHFE-HAB-01	PHYS-1: What validated acoustic model can predict the effect of structures, materials, crew and equipment on the acoustic environment of a spacecraft or habitat?	SHFE-HAB-01: What validated acoustic model can predict the effect of structures, materials, crew and equipment on the acoustic environment of a spacecraft or habitat?
Safety	PHYS-2	HAB	SHFE-HAB-02	PHYS-2: What tools can be used to evaluate habitability concepts for on-orbit and planetary missions?	SHFE-HAB-02: What tools can be used to evaluate habitability concepts for on-orbit and planetary missions?
Safety	SHFE 2.1.8.1	HAB	SHFE-HAB-03	SHFE 2.1.8.1: How can we determine the effects of combined vibration and acceleration on task performance?	SHFE-HAB-03: How can we determine the effects of combined vibration and acceleration on task performance?
Safety	SHFE 2.3.b	HAB	SHFE-HAB-04	SHFE 2.3.b: How can existing models be modified to adequately represent the specified user population (e.g. field of view, visibility) in reduced gravity and be portable to other simulations environments?	SHFE-HAB-04: How can existing models be modified to adequately represent the specified user population (e.g. field of view, visibility) in reduced gravity and be portable to other simulations environments?
Safety	SHFE 2.3.1.1	HAB	SHFE-HAB-05	SHFE 2.3.1.1: What is the effect of microgravity on spinal elongation?	SHFE-HAB-05: What is the effect of microgravity on spinal elongation?
Safety	SHFE 2.3.a	HAB	SHFE-HAB-06	SHFE 2.3.a (SBIR): How can crews easily document human factors related issues that occur on orbit?	SHFE-HAB-06 (SBIR): How can crews easily document human factors related issues that occur on orbit?
Safety	PCBH-1	HCI	SHFE-HCI-02	PCBH-1: BHP Campaign Integrated Gap: What aspects of cognitive function change during long duration missions and are they related to neural structural changes?	SHFE-HCI-02: BHP Campaign Integrated Gap: What aspects of cognitive function change during long duration missions and are they related to neural structural changes?
Safety	HCI-2	TASK	SHFE-TASK-02	HCI-2: What model-based HF Tools can assist with the design and evaluations of spacecraft systems and task procedures?	SHFE-TASK-02: What model-based HF Tools can assist with the design and evaluations of spacecraft systems and task procedures?
Task Design	HRI-1	HARI	SHFE-HARI-01	HRI-1: What guidelines and tools can we develop to enable system designers and mission planners to conduct systematic task/needs analyses at the appropriate level of detail to allocate work among appropriate agents (human and automation)?	SHFE-HARI-01: What guidelines and tools can we develop to enable system designers and mission planners to conduct systematic task/needs analyses at the appropriate level of detail to allocate work among appropriate agents (human and automation)?
Task Design	HRI-2	HARI	SHFE-HARI-02	HRI-2: How can performance, efficiency, and safety guidelines be developed for effective information sharing between humans and automation, such that appropriate trust and situation awareness is maintained?	SHFE-HARI-02: How can performance, efficiency, and safety guidelines be developed for effective information sharing between humans and automation, such that appropriate trust and situation awareness is maintained?
Task Design	SHFE 1.1.2.1.1	HARI	SHFE-HARI-03	SHFE 1.1.2.1.1: How can performance, efficiency, and safety guidelines be developed for appropriate task automation and the effective allocation of tasks between humans and automation?	SHFE-HARI-03: How can performance, efficiency, and safety guidelines be developed for appropriate task automation and the effective allocation of tasks between humans and automation?
Task Design	SHFE 1.1.2.2.1	HCI	SHFE-HCI-05	SHFE 1.1.2.2.1: How can we develop standard measurement techniques and metrics for evaluating the quality of user interfaces with specific attention to the usability of an interface?	SHFE-HCI-05: How can we develop standard measurement techniques and metrics for evaluating the quality of user interfaces with specific attention to the usability of an interface?
Task Design	UWS-1	TASK	SHFE-TASK-01	UWS-1: How can workload measures and tools be developed to unobtrusively monitor and trend workload throughout the mission design and verification cycle in a consistent manner	SHFE-TASK-01: How can workload measures and tools be developed to unobtrusively monitor and trend workload throughout the mission design and verification cycle in a consistent manner

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DoD's HFACS Based on Reason's "Swiss Cheese Model of Human Error

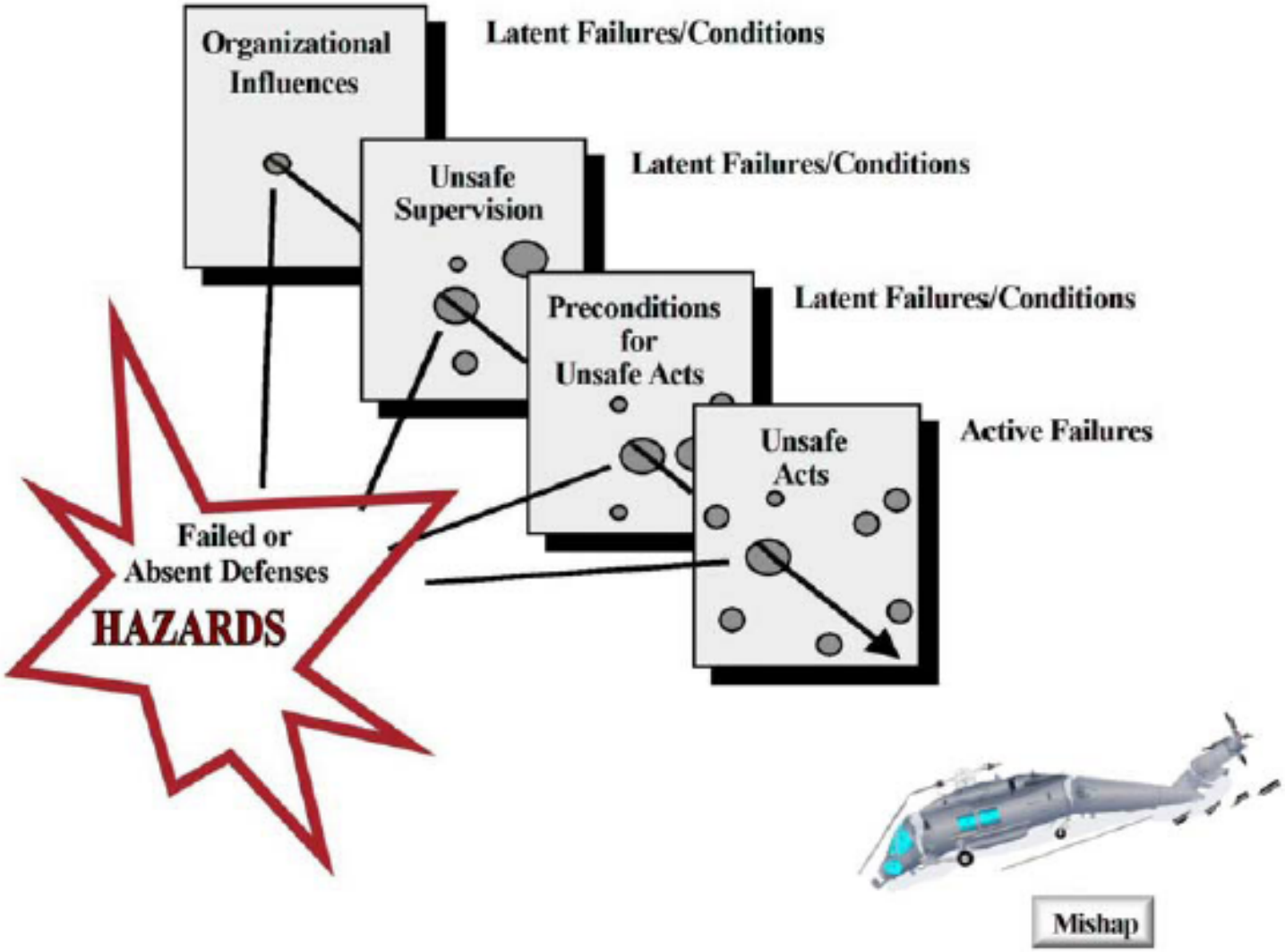
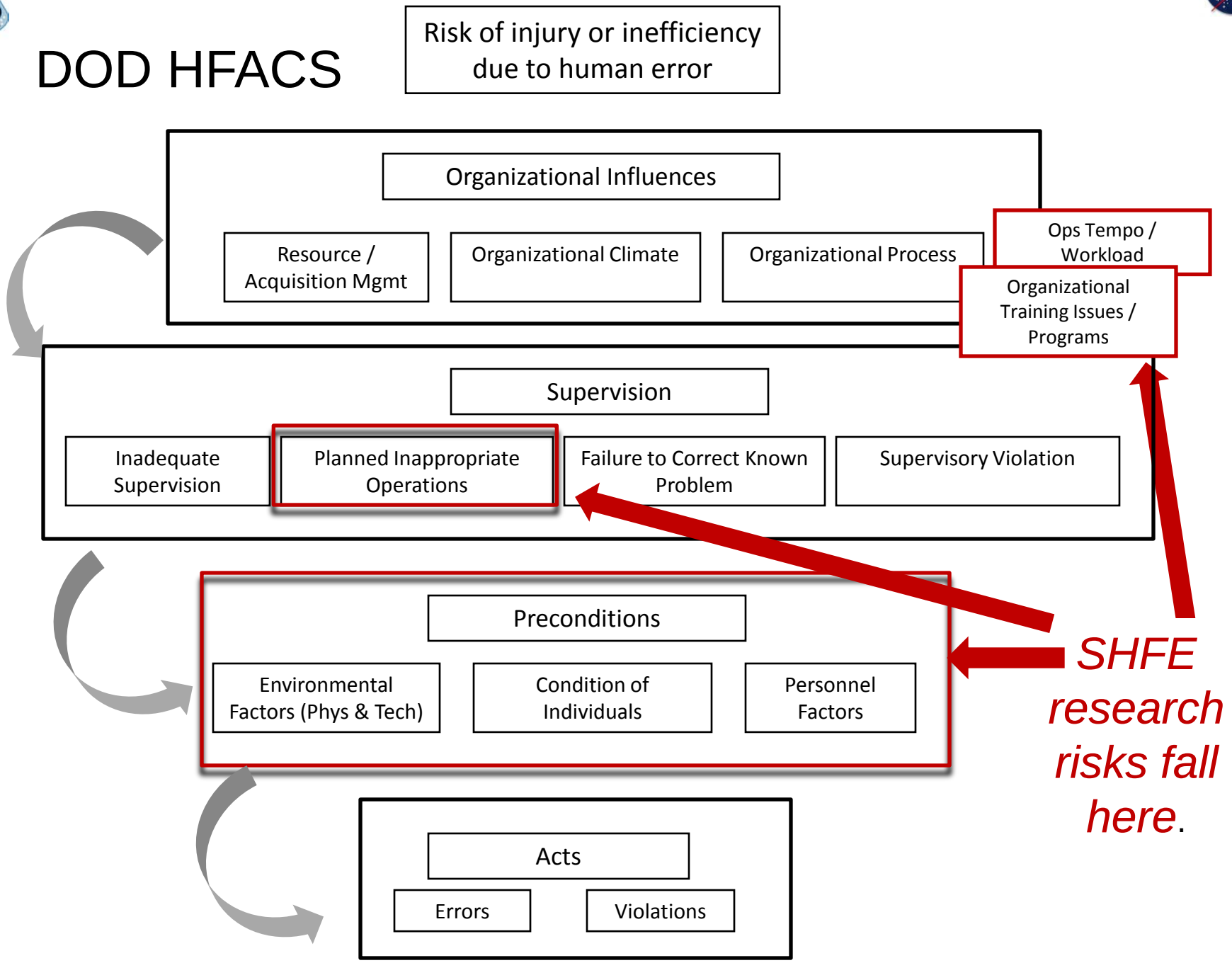


Figure 1. The "Swiss Cheese" Model (adapted from Reason, 1990)

SHFE Research and HFACS

- The primary focus of SHFE research is on Preconditions
  - minimize the likelihood of these preconditions through relevant research
- We have the knowledge to control some preconditions; further research is not required
  - This knowledge is captured in the Human System Integration Requirements and the Space Flight Human Systems Standards, vol 2
  - We don't know enough about other preconditions to ensure they won't occur, especially for long duration
- Two SHFE topics, workload and training, are captured at the Organizational Influences level

DOD HFACS


Risk of injury or inefficiency due to human error
Organizational Influences
Resource / Acquisition Mgmt
Organizational Climate
Organizational Process
Ops Tempo / Workload
Organizational Training Issues / Programs
Supervision
Inadequate Supervision
Planned Inappropriate Operations
Failure to Correct Known Problem
Supervisory Violation
Preconditions
Environmental Factors (Phys & Tech)
Condition of Individuals
Personnel Factors
Acts
Errors
Violations
SHFE research risks fall here.

SHFE Research and HFACS (cont.)

- The two highest HFACS tiers (Organizational Influences and Supervision) are generally policy level or organizational level factors
  - These need to be addressed in order to implement a safety program or a risk reduction program
  - These are generally beyond the current scope of the SHFE Project (and HRP)
- Some categories are entirely within the domain of SHFE, while some categories are shared with other HRP Elements
- Some of the HFACS categories are primarily the province of other HRP Elements
  - Psycho-Behavioral Factors, Adverse Physiological States, Sensorimotor Adaptation, Self-Imposed Stress

Status of Evidence Reports and RMAT Vetting

- Draft Evidence Reports have been completed; Final versions scheduled for completion in May, to allow for Export Control processing prior to HRP's NRA solicitation.

- All new Risks entered in the RMAT system
- CR presented to HSRB
  - RID resolution close to completion